UNITED STATES DISTRICT COURT
DISTRICT OF MASSACHUSETTS

AVIDYNE CORPORATION, a Delaware corporation,

Plaintiff,

v.

L-3 COMMUNICATIONS AVIONICS SYSTEMS, INC., f/k/a B.F. GOODRICH AVIONICS SYSTEMS, INC., a Delaware corporation,

Defendant.

MAGISTRATE JUDGE RBC

04 - 12672 NG

C.A. No. ________

RECEIPT # ________
AMOUNT $ 150.00
SUMMONS ISSUED 1
LOCAL RULE 4.1 -
WAIVER FORM -
MCF ISSUED -
BY DPTY. CLK. M.P.
DATE 12/21/2004

DECLARATORY JUDGMENT COMPLAINT

Plaintiff Avidyne Corporation ("Avidyne") alleges as follows:

1. Avidyne is a Delaware corporation with its principal place of business in Lincoln, Massachusetts.

2. On information and belief, defendant L-3 Communications Avionics Systems, Inc. f/k/a B.F. Goodrich Avionics Systems, Inc. ("L-3") is a Delaware corporation with its principal place of business in Grand Rapids, Michigan. On information and belief, L-3 is the assignee of U.S. Patent No. 5,841,018 (the "'018 Patent").

3. This is an action under the Federal Declaratory Judgment Act, 28 U.S.C. §§ 2201 and 2202, for a declaration pursuant to the patent laws of the United States, 35 U.S.C. § 1 *et seq.*, that the '018 Patent is not infringed by Avidyne or is invalid or both.

4. This court has subject matter jurisdiction under 28 U.S.C. §§ 1331 (federal question), 28 U.S.C. § 1332 (diversity of parties), and 1338(a) (action arising under and Act of Congress relating to patents). On information and belief, this Court has personal jurisdiction over L-3 because L-3 has constitutionally sufficient contacts with Massachusetts as to make personal

jurisdiction proper in this Court. In particular, on information and belief, L-3 conducts or solicits business within this district and elsewhere in Massachusetts and derives substantial revenue from the sales of its products and/or services within this district and elsewhere in Massachusetts.

VENUE

5. Venue is proper in this judicial district under 28 U.S.C. § 1391 (b) and (c).

GENERAL ALLEGATIONS

6. Avidyne designs, manufactures, and sells integrated flight deck systems for aircraft.

7. Avidyne sells an integrated flight deck system under the mark FLIGHTMAX ENTEGRA.

8. L-3 has alleged that the primary flight display of Avidyne's FLIGTMAX ENTEGRA flight deck system infringes the '018 Patent. A true and accurate copy of the '018 Patent is attached hereto as Exhibit 1.

9. By letter dated December 14, 2004, Frederick S. Burkhart, counsel for L-3 Avionics, expressly charged that the primary flight display of Avidyne's FLIGHTMAX ENTEGRA infringes the '018 Patent. A true and accurate copy of Mr. Burkhart's December 14, 2004 letter is attached hereto as Exhibit 2.

10. In his December 14, 2004 letter, Mr. Burkhart demanded that Avidyne cease and desist "from all making, using, selling and offering for sale the infringing [FLIGHTMAX] product" unless Avidyne secures a license under the '018 Patent. Mr. Burkhart also demanded that Avidyne disclose "the number of PFD systems that have been sold or otherwise disposed of" by Avidyne. Mr. Burkhart gave Avidyne fourteen days to comply with these demands.

11. L-3's actions and, in particular, Mr. Burkhart's December 14, 2004 letter, created on the part of Avidyne a reasonable apprehension that it will face an infringement suit if it continues to make, use, sell, or offer to sell its FLIGHTMAX ENTEGRA flight deck display. More specifically, Avidyne reasonably believes that L-3 intends to commence litigation for infringement of the '018 Patent unless it yields to L-3's demands.

12. Avidyne denies that it infringes any valid claim of any of the '018 Patent and denies the validity of that patent's claims.

13. An actual and justiciable controversy exists between Avidyne and L-3 concerning whether Avidyne infringes any valid claim of the '018 Patent. Avidyne now seeks a declaratory judgment that it does not infringe any valid claim of the '018 Patent and/or that the claims of the '018 Patent are invalid.

FIRST CLAIM FOR RELIEF
(Declaration of Non-Infringement as to the '018 Patent)

14. Avidyne incorporates by reference paragraphs 1 through 13 above as though fully set forth herein.

15. Avidyne is not directly infringing, contributorily infringing, or actively inducing others to infringe any valid claim of the '018 Patent as properly construed.

16. Avidyne is entitled to a declaration from the Court establishing that it is not directly infringing, contributorily infringing, or actively inducing others to infringe any valid claim of the '018 Patent as properly construed.

SECOND CLAIM FOR RELIEF
(Declaration of Invalidity of the '018 Patent)

17. Avidyne incorporates by reference paragraphs 1 through 13 above as though fully set forth herein.

18. Upon information and belief, the claims of the '018 Patent are invalid for failure to comply with one or more of the requirements for patentability set forth in 35 U.S.C. §§ 102 or 103.

19. Avidyne is entitled to a declaration from the Court establishing that some or all of the claims of the '018 Patent are invalid for failure to comply with one or more of the requirements for patentability set forth in 35 U.S.C. §§ 102 or 103.

WHEREFORE, plaintiff Avidyne Corporation respectfully requests that the Court:

1. Enter judgment in its favor on each of the claims asserted in this Complaint (and any subsequent amendments thereto);

2. Declare that Avidyne does not infringe any valid claim of the '018 Patent;

3. Declare that some or all of the claims of the '018 Patent are invalid;

4. Award Avidyne its legal costs and expenses;

5. Find this case to be "exceptional" and award Avidyne the legal fees it incurred in prosecuting this action, pursuant to 35 U.S.C. § 285; and

6. Grant such other and/or further relief as the Court deems just and equitable.

LOCAL RULE 7.3 CERTIFICATION

Pursuant to Local Rule 7.3, the undersigned certifies that as of this date Avidyne Corporation is a privately held company and that no public company has an ownership interest of 10% or more in Avidyne.

Dated: December 21, 2004

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US005841018A

United States Patent [19]

Watson et al.

[11] Patent Number: 5,841,018

[45] Date of Patent: Nov. 24, 1998

[54] METHOD OF COMPENSATING FOR INSTALLATION ORIENTATION OF AN ATTITUDE DETERMINING DEVICE ONBOARD A CRAFT

[75] Inventors: **Gary Stewart Watson**, Ada; **Krishna Devarasetty**, Kentwood, both of Mich.

[73] Assignee: **B. F. Goodrich Avionics Systems, Inc.**, Akron, Ohio

[21] Appl. No.: **785,553**

[22] Filed: **Dec. 13, 1996**

[51] **Int. Cl.**[6] **G01C 17/38**; G01C 21/00

[52] **U.S. Cl.** .... **73/1.81**; 73/178 R; 244/164

[58] **Field of Search** .... 73/1.79, 1.81, 73/1.78, 1.75, 1.76, 1.77, 178 R; 244/164, 171

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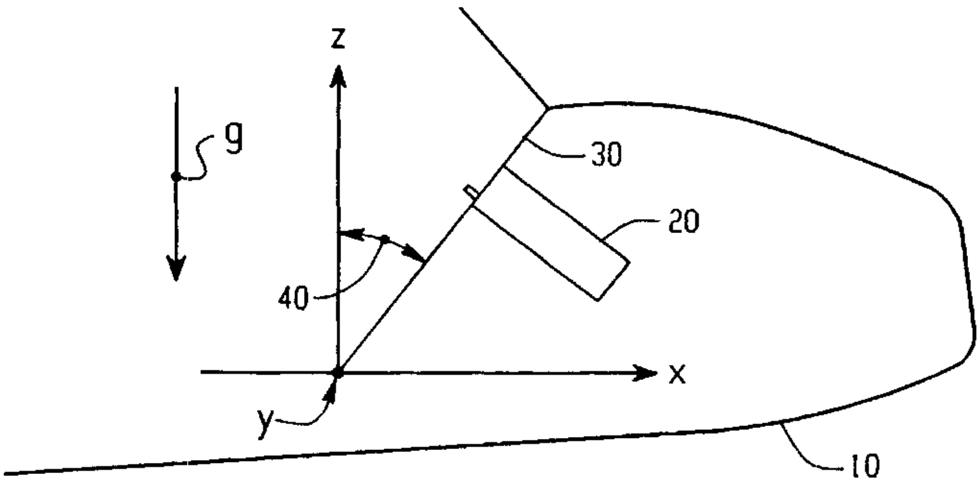
Primary Examiner—Max H. Noori
Attorney, Agent, or Firm—William E. Zitelli

[57] **ABSTRACT**

In accordance with the disclosed method, an attitude determining device which is installed onboard a mobile craft, like an aircraft, for example, at an unknown orientation with respect to the reference coordinate system of the craft senses its installation orientation with respect to an earth frame coordinate system when the craft is at rest to obtain a static orientation measurement thereof. Thereafter, an attitude of the mobile craft with respect to the earth frame is measured with the attitude determining device and such measurement is compensated with the static orientation measurement to obtain attitude information of the craft's reference coordinate system with respect to the earth frame coordinate system. The installation orientation of the attitude determining device may be sensed while the craft is at rest in either a leveled or unleveled condition.

20 Claims, 4 Drawing Sheets



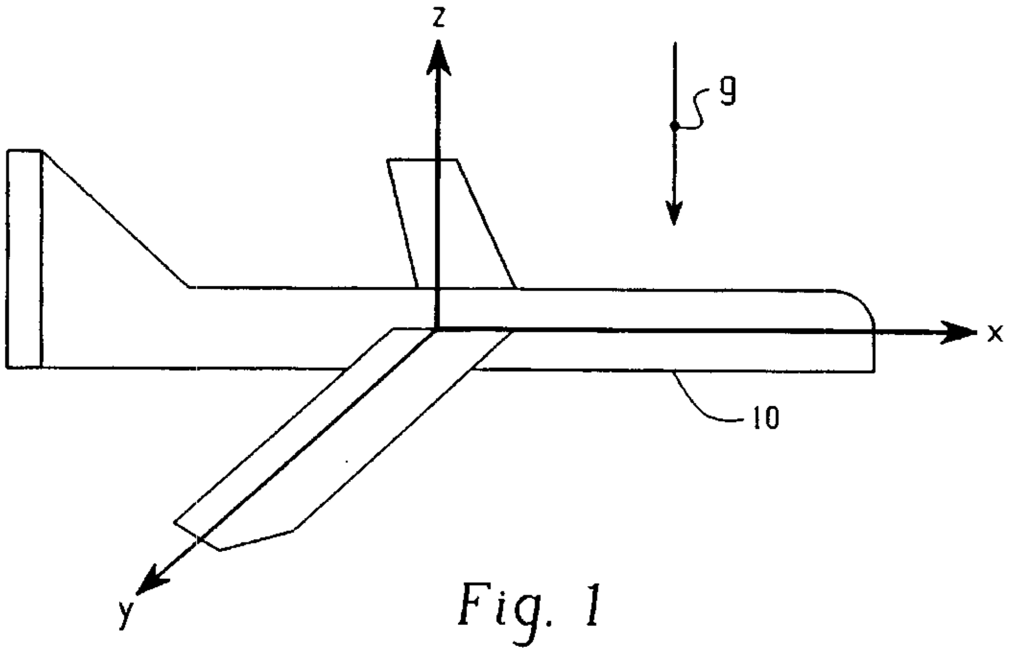


Fig. 1

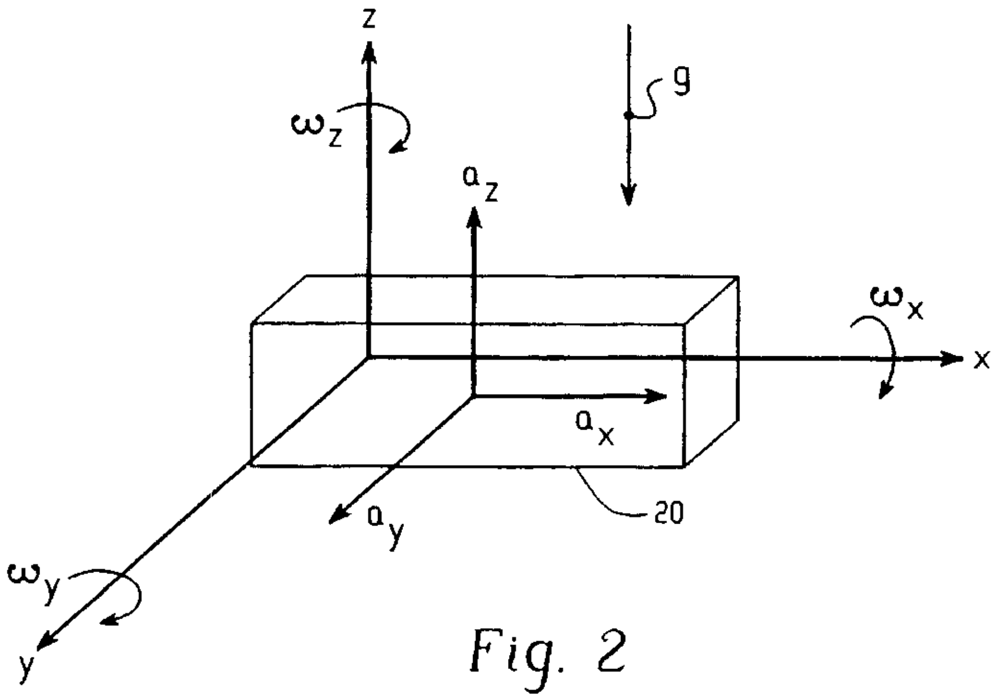


Fig. 2

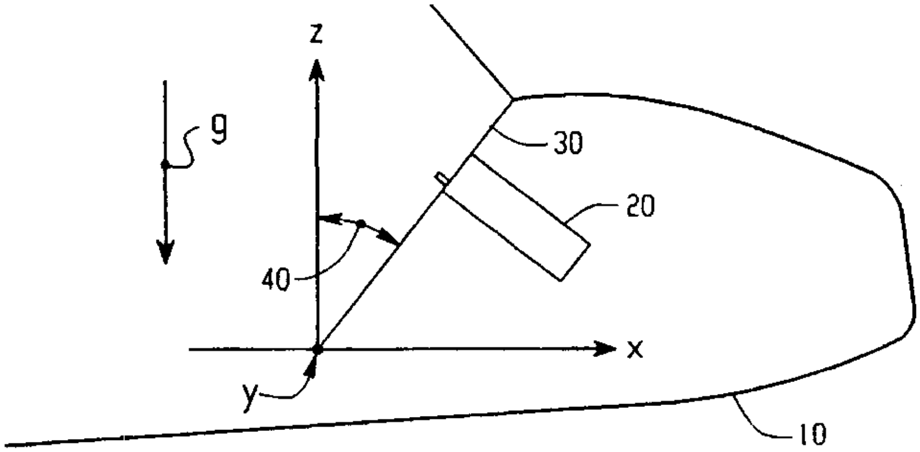


Fig. 3

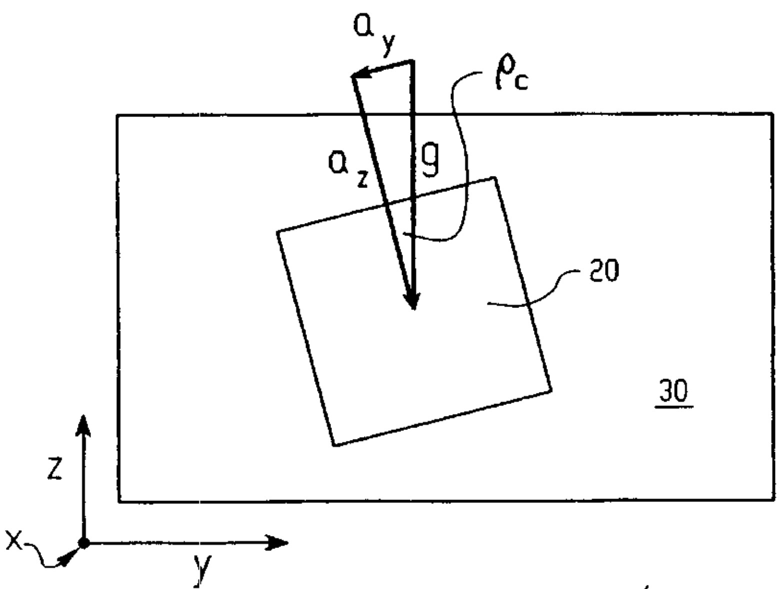
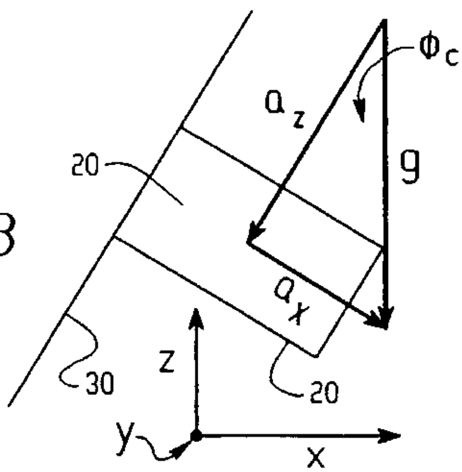


Fig. 4A

Fig. 4B



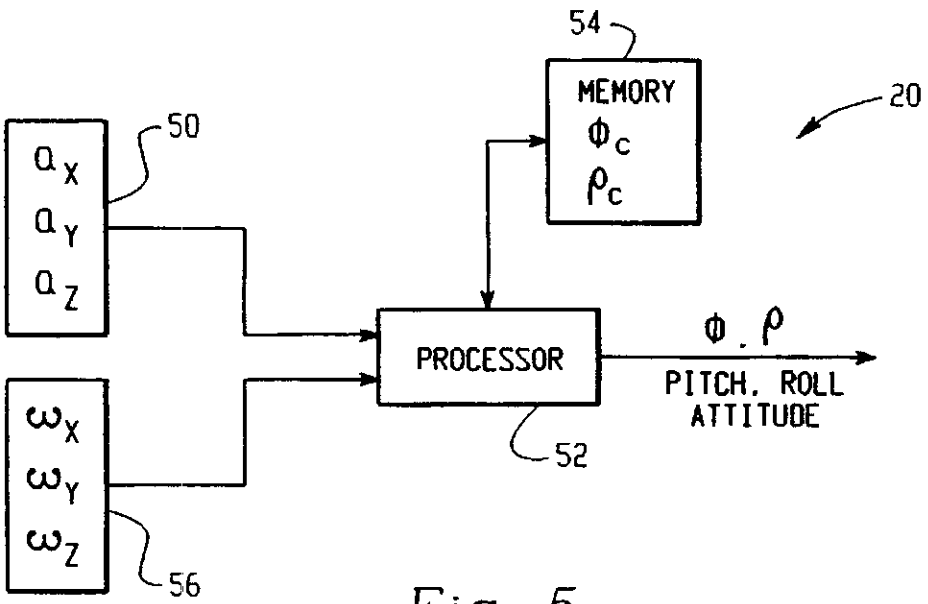
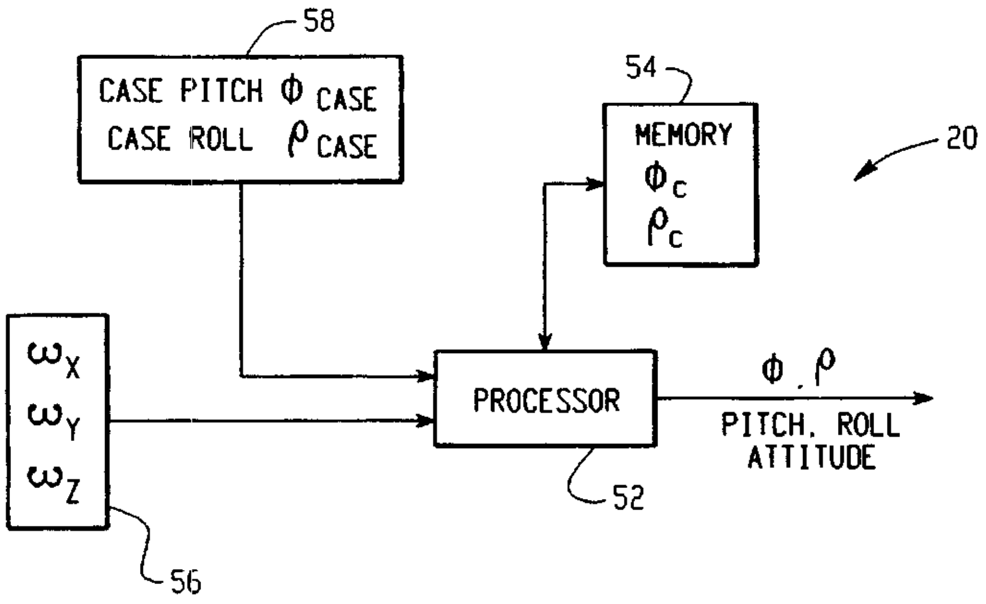

54
MEMORY
Φ_c
ρ_c
20
50
a_X
a_Y
a_Z
PROCESSOR
Φ, ρ
PITCH, ROLL
ATTITUDE
52
ω_X
ω_Y
ω_Z
56

Fig. 5


58
CASE PITCH Φ CASE
CASE ROLL ρ CASE
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ω_X
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Φ, ρ
PITCH, ROLL
ATTITUDE
52
56

Fig. 6

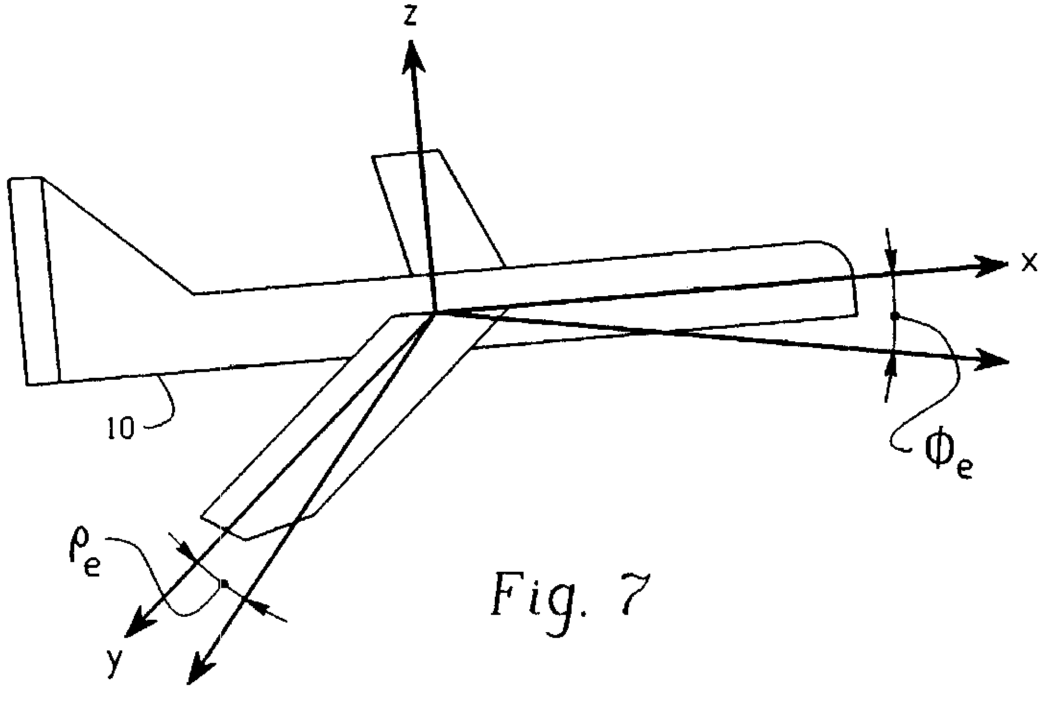

Fig. 7

METHOD OF COMPENSATING FOR INSTALLATION ORIENTATION OF AN ATTITUDE DETERMINING DEVICE ONBOARD A CRAFT

BACKGROUND OF THE INVENTION

The present invention relates to attitude determining devices onboard a mobile craft for determining the attitude of the craft's reference coordinate system with respect to an earth frame of reference, and more specifically, to a method of compensating an attitude measurement of such device for an unknown installation orientation with respect to the reference coordinate system of the craft.

Attitude determining devices for mobile craft, like aircraft, for example, measure the attitude of the moving craft with respect to an outside reference coordinate system, typically known as earth frame. The devices may be installed at a location in the craft in such a manner to be mechanically aligned with the reference coordinate system of the craft. The reference coordinate system of conventional aircraft comprises three orthogonal axes which include a longitudinal or X axis, a lateral or Y axis, and a vertical or Z axis. Motion of the aircraft is generally described as roll which is a rotation about the X axis, pitch which is a rotation about the Y axis and yaw which is a rotation about the Z axis. Pitch, roll and yaw positions are measured as the current angle between the aircraft reference coordinate system and earth frame. Conventionally, aircraft attitude determining devices primarily measure attitude of the aircraft in pitch and roll.

Any inaccuracy in installing an attitude determining device in the craft with respect to the reference coordinate system thereof will result in inaccurate measurement and presentation of the attitude of the craft to either the pilot or other system using the attitude information for display or control purposes. Currently, a method of installing these devices in an aircraft has been to accurately level the aircraft first, and then, install the device using shims or other mechanical apparatus to correctly position the device with respect to the three orthogonal axes forming the coordinate system of the aircraft. This procedure of leveling is adequate for devices mounted in locations of the aircraft remote from the cockpit, but when the device is to be mounted in a cockpit location, such as on an instrument panel, for example, shimming or other mechanical means of adjusting the installation orientation thereof may be precluded due to viewing angle restrictions, aesthetics, . . . etc. Accordingly, some other compensation method will be required.

Currently, units installed on an instrument panel in the cockpit of an aircraft have slots for roll axis alignment and internal mechanical means to accommodate pitch angles other than zero. However, these accommodations for pitch angles make the assumption of zero error in manufacturing tolerances of the aircraft panel angle.

Accordingly, the inventive method described herein below ensures a substantially accurate measurement of aircraft attitude by the attitude determining device with respect to the earth frame of reference. The static installation orientation is automatically determined by the device itself and the attitude measurement is compensated therewith in a processor of the device. Thus, the drawbacks of the current mechanical leveling and alignment procedures are avoided.

SUMMARY OF THE INVENTION

In accordance with the present invention, an attitude determining device which is installed onboard a mobile craft at an unknown orientation with respect to the reference coordinate system of the craft senses its installation orientation with respect to an earth frame coordinate system when the craft is at rest to obtain a static orientation measurement. An attitude of the mobile craft is measured with the attitude determining device and such measurement is compensated with the static orientation measurement to obtain attitude information of the craft's reference coordinate system with respect to the earth frame coordinate system.

In one embodiment, the acceleration of the attitude determining device is sensed for each of the axes of the reference coordinate system of the mobile craft while at rest and leveled, and a static attitude pitch and static attitude roll of the device are determined from trigonometric functions of ratios of the sensed accelerations. Accordingly, both of the measured attitude pitch and roll of the device are compensated with the static attitude pitch and the static attitude roll, respectively, in the attitude determining device to render attitude information of the craft's reference coordinate system with respect to the earth frame coordinate system.

In another embodiment, a static attitude of the mobile craft in pitch and roll is obtained while the craft is at rest and unleveled. Thereafter, the static attitude craft pitch is used in determining the static attitude pitch of the device and the static attitude craft roll is used in determining the static attitude roll of the device and such static attitude pitch and roll are used respectively to compensate for the measured attitude pitch and roll of the mobile craft in the attitude determining device.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an illustration of an aircraft, with it's reference coordinate system, onboard which an attitude determining device may be installed.

FIG. 2 is an illustration of an attitude determining device including conventional internal acceleration and rate sensors for three orthogonal axes X, Y and Z.

FIG. 3 is a sketch of an attitude determining device mounted on a panel in the cockpit of an aircraft at an unknown orientation to the reference coordinate system of the craft.

FIGS. 4A and 4B are illustrations exemplifying methods of determining the pitch and roll of the attitude determining device onboard a mobile craft using sensed acceleration measurements of the device in accordance with the present invention.

FIG. 5 is a block diagram schematic representing a suitable embodiment of an attitude determining device for performing the method in accordance with the present invention.

FIG. 6 is a block diagram schematic representing an alternate embodiment of an attitude determining device for performing another aspect of the present invention.

FIG. 7 is an illustration of an aircraft having its reference coordinate system unleveled with respect to an earth frame coordinate system allowing for offset angles of pitch and roll respectively from a level attitude.

DESCRIPTION OF THE PREFERRED EMBODIMENT

For the present embodiment, an aircraft will be used, by way of example, as a mobile craft, but it is understood that other similar craft may be used where ever an attitude of the craft is desired and measured with respect to an earth frame of reference coordinate system, hereinafter referred to sim-

ply as earth frame. An aircraft with its reference coordinate system is shown in FIG. 1 including a longitudinal axis depicted as an X axis, a lateral axis depicted as a Y axis, and a vertical axis depicted as a Z axis. Accordingly, roll of the aircraft may be measured as the angular rotation about the X axis, pitch of the aircraft may be measured by the angular rotation about the Y axis and yaw of the aircraft may be measured by the angular rotation about the vertical Z axis. All of these angles are measured with respect to the earth frame. Conventionally, an attitude determining device of an aircraft measures attitude in pitch and roll.

To accurately level the aircraft **10** such that its reference coordinate axes coincides with earth frame, the aircraft is adjusted in attitude such that an acceleration a_z sensed for the Z axis is set substantially equal to a gravity vector g, and the accelerations sensed in the X axis, a_x and in the Y axis, a_y, are set substantially to zero. When these conditions are sensed and stabilized, the aircraft **10** is considered leveled.

FIG. **2** is an illustration of an attitude determining device **20** which may include conventional internal acceleration sensors for the three orthogonal axes X, Y and Z, and may also include conventional rate sensors to measure the rotational motion ω_x, ω_y, and ω_z which are the rotational motions about the respective axes X, Y and Z. An example of such a device is an inertial reference unit manufactured by Honeywell, Inc., model no. HG2001AB02. The internal acceleration sensors (not shown) determine the gravity vector or local vertical g. Thereafter, rotational motion about the respective axes X, Y and Z is sensed by the rate sensors (also not shown), the output of which being integrated over time to maintain a real time craft attitude. Any accumulated integration errors may be removed during static periods by re-aligning the derived output of the device to the local vertical g which procedure is referred to as leveling or erection. These calculations are conventionally performed by a processor internal to the device which samples the sensor outputs and performs the initial and continuous algorithms to produce an attitude solution to be used for display in the aircraft or for a guidance and/or control application for the aircraft.

The attitude determining device **20** may be of a strap down system which is mechanically mounted to the case of the device or a gimballed instrument having elements which are free to rotate in inertial space independent of the case of the unit. In either case, in locating the attitude determining device **20** on board a moving craft, like an aircraft, for example, it may be installed at an unknown orientation with respect to the reference coordinate system of the craft which in the present embodiment are the three orthogonal axes X, Y and Z. It is desired that the device be mounted level with the lateral and longitudinal axes of the craft and aligned with the longitudinal X axis such as shown in FIG. **2**, but this may not always be possible due to errors in mechanical leveling or adjusting of the orientation and due to errors in manufacturing tolerances of the device and the aircraft structure where the device is being mounted. This is especially evident when the attitude determining device **20** is mounted on a panel in the cockpit of the aircraft **10** much as illustrated in the sketch of FIG. **3**.

Referring to FIG. **3**, when the attitude determining device **20** is installed on an aircraft instrument panel **30**, the device may not be aligned with the "waterline" or level line of the aircraft in order to compute accurate attitude information. This is because the panel is often not perpendicular to the waterline and it is not possible in most cases to exactly compensate mechanically for the panel angle offset **40** to the vertical or Z axis. In accordance with the present invention, a method is described below which ensures an accurate calculation of the attitude of a moving craft, like an aircraft, for example, by measuring the installation orientation of the device **20** with respect to the reference coordinate axes of the aircraft and compensating for this orientation mathematically in a processor of the device **20**.

In the present embodiment, upon installation of the device **20** on the instrumentation panel **30** of the craft **10**, whose reference coordinate axes have been leveled to coincide with earth frame, the installation orientation thereof is automatically measured by the installed device **20** and stored in a non-volatile memory thereof. For example, the pitch, ϕ_c and the roll, ρ_c are measured using the acceleration sensors of the device **20** and this measurement is exemplified by the illustrations of FIGS. **4A** and **4B**. In FIG. **4A**, the panel **30** and mounted device **20** is shown in the plane of the axes Z and Y to describe the measurement of the roll angle ρ_c of the installed device **20**. In the plane of the axes Z and Y, the acceleration vectors a_y and a_z are added vectorially to yield the gravity vector g. The installation roll angle ρ_c about the X axis is the angle between the vectors g and a_z and may be determined mathematically in accordance with a trigonometric function of the ratio of a_y to a_z.

Similarly, the perspective of the device **20** installed on the panel **30** in the plane of the axes X and Z is shown in FIG. **4B**. Referring to FIG. **4B**,in this perspective, the acceleration vectors a_z and a_x add up vectorially to yield the gravity vector g and the pitch angle ϕ_c is the angle between the vectors g and a_z which is a rotation about the Y axis. The installation pitch angle ϕ_c may be determined mathematically in accordance with a trigonometric function of the ratio of a_x to a_z. In the present embodiment, the trigonometric function used for determining the installed roll and pitch angles for static orientation of the device **20** is the arcsine.

A block diagram schematic representing a suitable embodiment of the attitude determining device is shown in FIG. **5**. Referring to FIG. **5**, after the device is installed on the instrument panel of a leveled craft **10**, for example, and power is subsequently activated to the device **20**, an internal processor **52** of the device **20** samples the outputs of the acceleration senors depicted in the block **50** in all three axes a_x,a_y,a_z. The static angles of the device **20** with respect to earth frame are determined by the processor **52** from the static acceleration measurements based on the trigonometric function described above. The installation angles ϕ_c and ρ_c are read from non-volatile memory **54** of the device **20** and the attitude of the craft **10** with respect to earth frame is determined by the processor **52** by subtracting these installation angles ϕ_c and ρ_c from the static angles of the device **20** with respect to earth frame. Thereafter, the pitch and roll attitude angles of the moving craft **10** are computed conventionally by the processor **52** via the rate sensors ω_x, ω_y, ω_z which are shown at block **56** of the device **20** and received by the processor **52**. In a gimballed attitude determining device the angles of the spin axis, measured using synchros or other such devices, with respect to the case are corrected by subtracting the installation angles ϕ_c and ρ_c to yield actual aircraft pitch and roll attitude angles.

In summary, for the case in which the craft is leveled according to the description supplied above prior to sensing the installation orientation of device **20**, the processor **52** samples the outputs a_x,a_y and a_z of the acceleration sensors **50**. The static installation angles ϕ_c and ρ_c are determined by the processor **52** from the static acceleration measurements based on the trigonometric function described above and are stored in a non-volatile memory **54** for use in compensating the attitude measurements with respect to earth frame.

Power to device **20** may then be removed. Subsequent power application to device **20** would allow a measurement of the attitude of the aircraft, i.e. orientation of the aircraft's reference coordinate axes with respect to earth frame, to be correctly determined by processor **52** using φ_c and ρ_c from the memory **54**.

In some applications, the attitude determining device **20** may not include acceleration sensors **50** but rather include level sensors for sensing directly the pitch ϕ_{case} and roll ρ_{case} of the installed case with respect to the earth frame. A block diagram schematic suitable for exemplifying an alternate embodiment of the device **20** including level sensors is shown in FIG. **6** with the level sensing depicted at **58**. Like reference numerals are given to the other elements of the device **20** to match those described in connection with the embodiment of FIG. **5**. In operation, the processor receives the installation orientation angles ϕ_{case} and ρ_{case} measured by the level sensors at **58** and stores them in the non-volatile memory **54** as ϕ_c and ρ_c to be accessed subsequently in compensating for the attitude angle measurements as described in connection with the embodiment of FIG. **5**.

The foregoing method provides for compensating for the installation orientation of the device **20** for a leveled craft. If the craft **10** is not in a level attitude as shown in the exemplified illustration of FIG. **7**, the actual unlevel aircraft attitude may be measured i.e. reference coordinate axes of the aircraft with respect to earth frame, allowing the processor **52** to determine the offset angles of pitch and roll, ϕ_e and ρ_e, respectively, from a level attitude. These pitch and roll angle offsets from a level condition of the aircraft may be input either manually or electrically to the processor **52** of the device **20** as shown in FIGS. **5** and **6**. In addition, the static installation angles are measured by device **20** with respect to the unleveled aircraft coordinate axes. In order for the processor **52** of device **20** to calculate the effective static installation pitch and roll angles, ϕ_c and ρ_c of the case with respect to a level reference coordinate system of the craft **10**, it may subtract the measured offset angles from their respective measured installation angles. The effective static orientation measurements of the case with respect to the craft's reference coordinate system may then be stored in the memory **54** as shown in FIGS. **5** and **6** in order to compensate for the installation orientation of the device in the craft **10** as described supra.

In attitude determining devices in which there is no non-volatile memory, the step of sensing the installation orientation of the device to obtain a static orientation measurement with respect to the reference coordinate system of the craft may be performed each time the power is turned on and the aircraft is in a static condition. The resulting static orientation measurement may be stored in the memory of the device for use in compensating for attitude measurements for the moving craft.

While the invention has been described herein in connection with a preferred embodiment, it should not be so limited, but rather construed in accordance with the breath and broad scope of the claim set appended hereto.

We claim:

1. A method of compensating for installation orientation of an attitude determining device on-board a mobile craft with respect to a reference coordinate system of said craft to obtain attitude information of said craft from said device based on an earth frame coordinate system, said method comprising the steps of:

installing said attitude determining device on-board said mobile craft at an unknown orientation with respect to said reference coordinate system of said craft;

sensing the installation orientation of said attitude determining device with respect to said earth frame coordinate system when said craft is at rest to obtain a static orientation measurement of said device;

measuring an attitude of said mobile craft with said attitude determining device; and

compensating said craft attitude measurement of said device with said static orientation measurement to obtain attitude information of said craft's reference coordinate system with respect to said earth frame coordinate system.

2. The method in accordance with claim **1** wherein the reference coordinate system of said craft includes three orthogonal axes—a vertical or z axis, a longitudinal or x axis and a lateral or y axis.

3. The method in accordance with claim **2** wherein the step of sensing includes:

leveling the craft while at rest such that the z axis is aligned with a gravity vector and no substantial at rest acceleration exists at the x and y axes;

sensing the acceleration at the device for each of said three axes—a(x), a(y) and a(z) while the craft is at rest and leveled; and

determining the static orientation measurement of said device based on a function of said three sensed axis accelerations—a(x), a(y) and a(z).

4. The method in accordance with claim **3** wherein the step of determining includes:

determining a static attitude pitch of the device as a trigonometric function of a ratio of the sensed accelerations a(x) and a(z); and

determining a static attitude roll of the device as a trigonometric function of a ratio of the sensed accelerations a(y) and a(z); and

wherein the static orientation measurement of the device comprises the determined static attitude pitch and static attitude roll.

5. The method in accordance with claim **4** wherein the step of measuring includes measuring an attitude pitch and an attitude roll of the mobile craft with said device; and the step of compensating includes compensating the measured attitude pitch with the static attitude pitch and compensating the measured attitude roll with the static attitude roll.

6. The method in accordance with claim **2** wherein the step of sensing includes:

sensing the acceleration at the device for each of said three axes—a(x), a(y) and a(z) while the craft is at rest and unleveled;

obtaining a static attitude of the craft while at rest and unleveled;

determining the static orientation measurement of said device based on said static craft attitude and a function of said three sensed axis accelerations—a(x), a(y) and a(z).

7. The method in accordance with claim **6** wherein the step of obtaining includes:

obtaining a static craft pitch and a static craft roll; and the step of determining includes:

determining a static attitude pitch of the device as a trigonometric function of a ratio of the sensed accelerations a(x) and a(z) and said static craft pitch; and

determining a static attitude roll of the device as a trigonometric function of a ratio of the sensed accelerations a(y) and a(z) and said static craft roll; and

wherein the static orientation measurement of the device comprises the determined static attitude pitch and static attitude roll.

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December 14, 2004

CERTIFIED MAIL
RETURN RECEIPT REQUESTED

Avidyne Corporation
55 Old Bedford Road
Lincoln, MA 01773

Attention: President

Re: Infringement of United States Patent 5,841,018
Our File: L3C01 A-104

Dear Sir or Madam:

This firm represents B.F. Goodrich Avionics Systems, Inc. which has changed its name to L-3 Communications Avionics Systems, Inc. ("L-3 Avionics"). This firm represents L-3 Avionics in intellectual property matters including procurement and enforcement of patent rights.

It has come to our attention that your company is marketing a FlightMax™ Entegra Primary Flight Display ("PFD") which infringes United States Patent 5,841,018 assigned to L-3 Avionics. Enclosed, for your information, is a copy of the '018 patent.

Our client is willing to license the '018 patent on a non-exclusive basis. Unless and until your company obtains a license under the '018 patent, it is necessary for you to cease and desist from all making, using, selling and offering for sale the infringing product. Please inform us if you wish to be informed of our client's licensing terms. We also require that you inform us of the number of PFD systems that have been sold or otherwise disposed of by your company.

We look forward to receiving your response within fourteen (14) days from the above-identified date.

Sincerely yours,

Frederick S. Burkhart

FSB:djr
L3C01 A-104
Enclosure
cc: L-3 Communications Avionics
Systems, Inc. (w/o enc.)

US005841018A 1960053

United States Patent [19]

Watson et al.

[11] Patent Number: 5,841,018

[45] Date of Patent: Nov. 24, 1998

[54] METHOD OF COMPENSATING FOR INSTALLATION ORIENTATION OF AN ATTITUDE DETERMINING DEVICE ONBOARD A CRAFT

[75] Inventors: **Gary Stewart Watson**, Ada; **Krishna Devarasetty**, Kentwood, both of Mich.

[73] Assignee: **B. F. Goodrich Avionics Systems, Inc.**, Akron, Ohio

[21] Appl. No.: **785,553**

[22] Filed: **Dec. 13, 1996**

[51] **Int. Cl.**^{6} **G01C 17/38**; G01C 21/00

[52] **U.S. Cl.** ..... **73/1.81**; 73/178 R; 244/164

[58] **Field of Search** ..... 73/1.79, 1.81, 73/1.78, 1.75, 1.76, 1.77, 178 R; 244/164, 171

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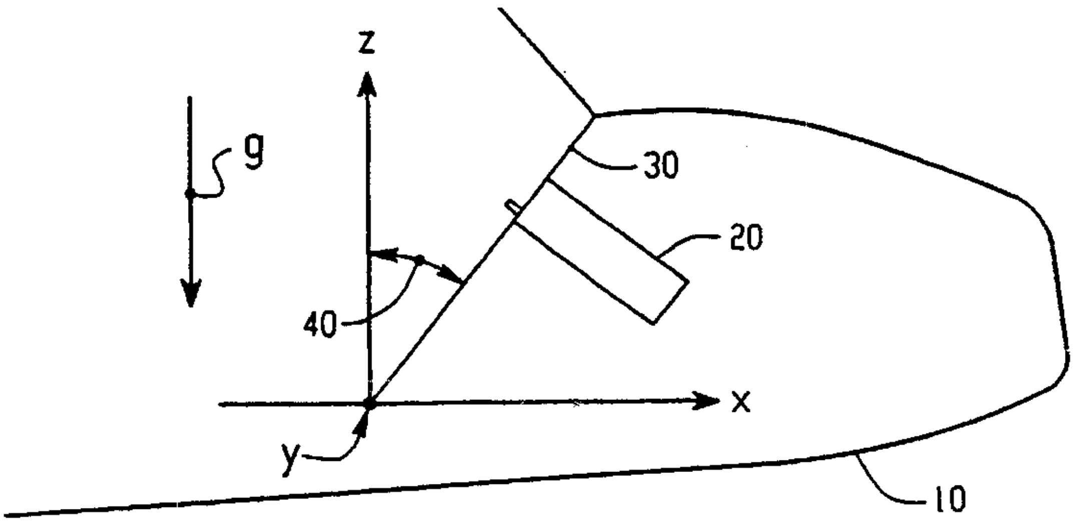
Primary Examiner—Max H. Noori
Attorney, Agent, or Firm—William E. Zitelli

[57] **ABSTRACT**

In accordance with the disclosed method, an attitude determining device which is installed onboard a mobile craft, like an aircraft, for example, at an unknown orientation with respect to the reference coordinate system of the craft senses its installation orientation with respect to an earth frame coordinate system when the craft is at rest to obtain a static orientation measurement thereof. Thereafter, an attitude of the mobile craft with respect to the earth frame is measured with the attitude determining device and such measurement is compensated with the static orientation measurement to obtain attitude information of the craft's reference coordinate system with respect to the earth frame coordinate system. The installation orientation of the attitude determining device may be sensed while the craft is at rest in either a leveled or unleveled condition.

20 Claims, 4 Drawing Sheets



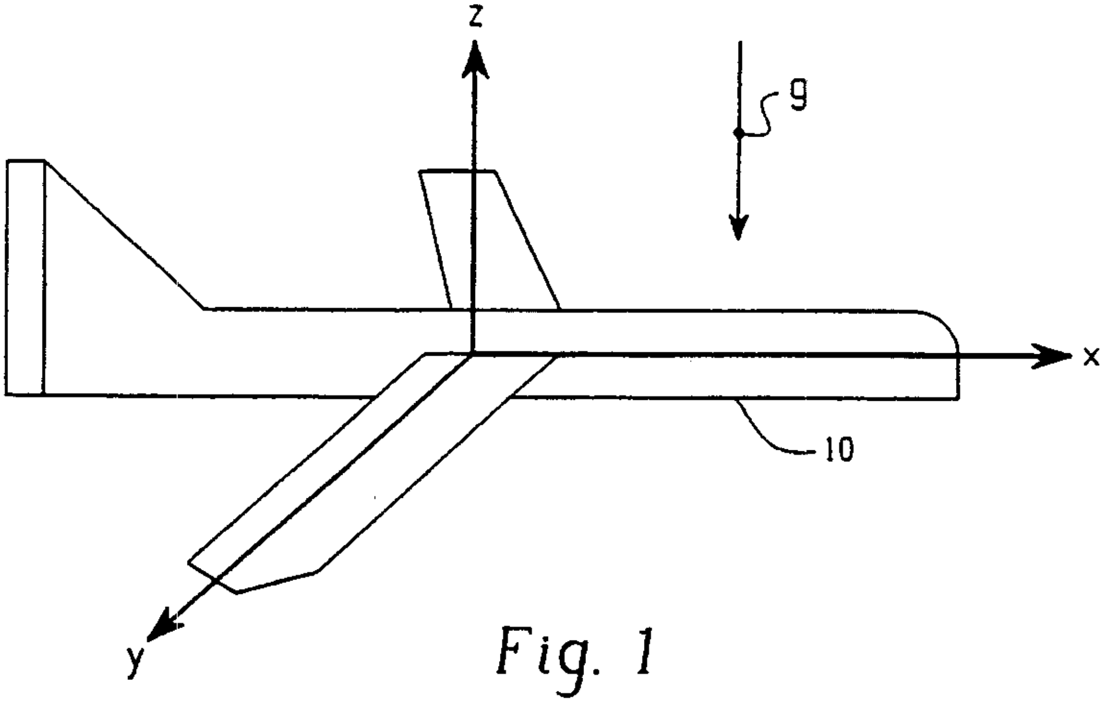


Fig. 1

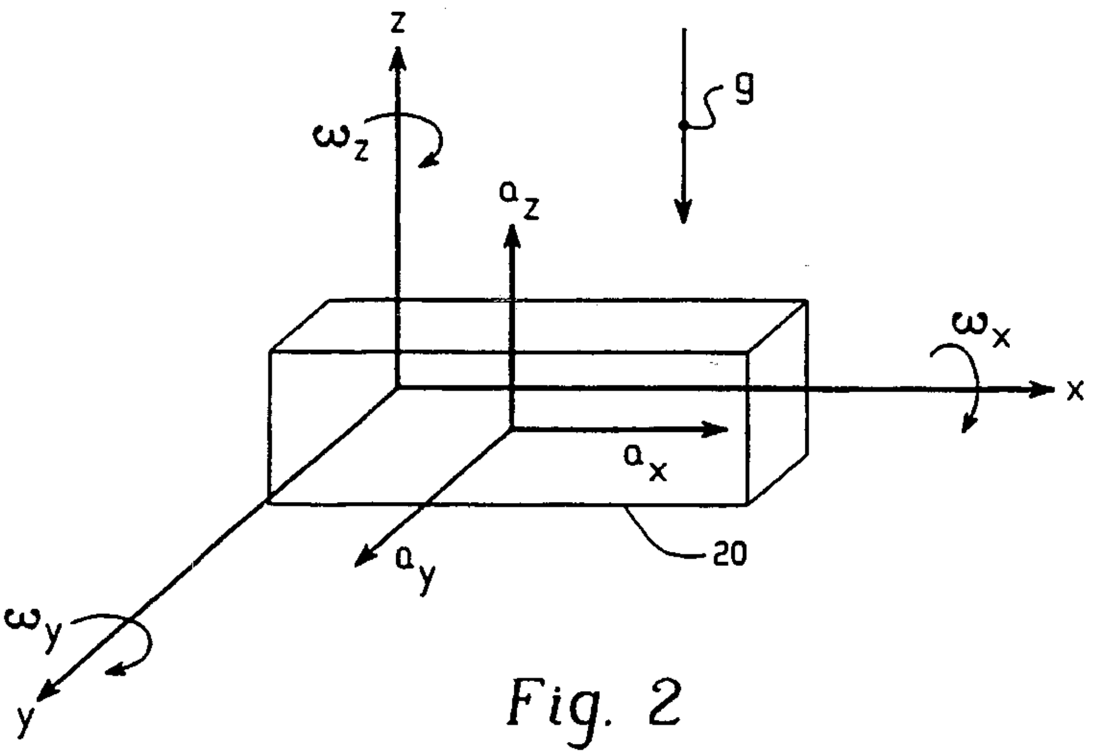


Fig. 2

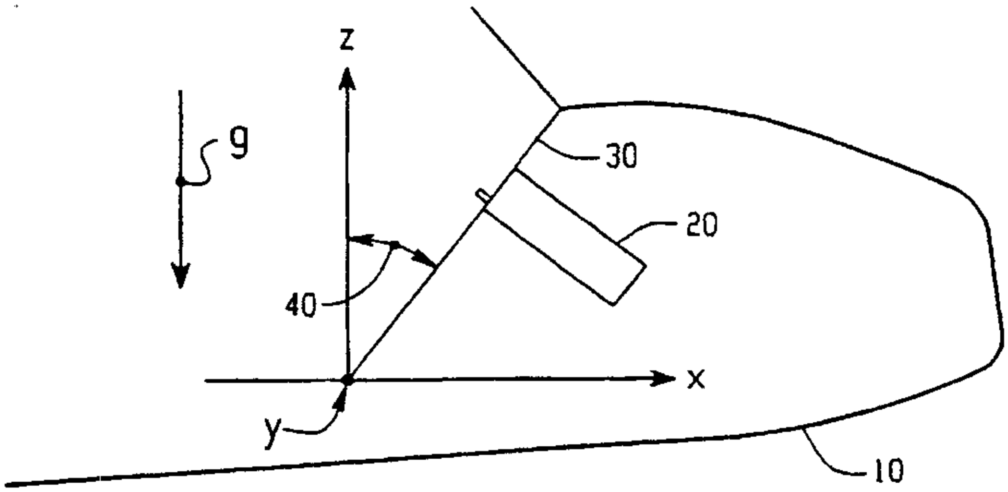


Fig. 3

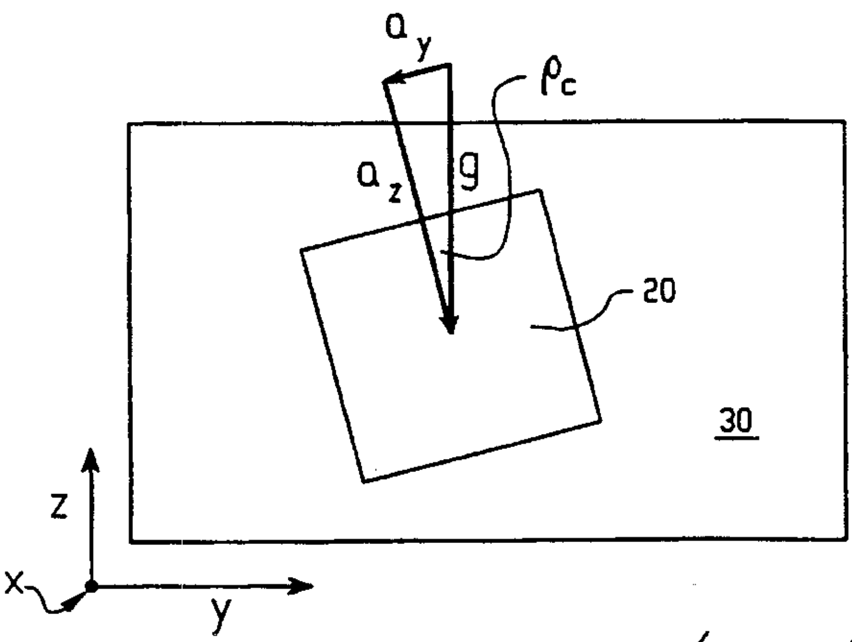


Fig. 4A

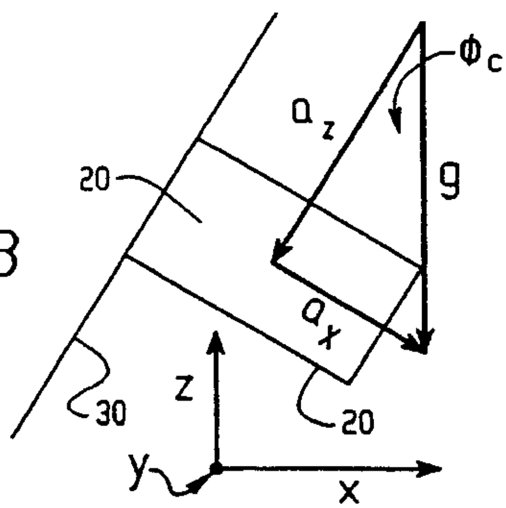


Fig. 4B

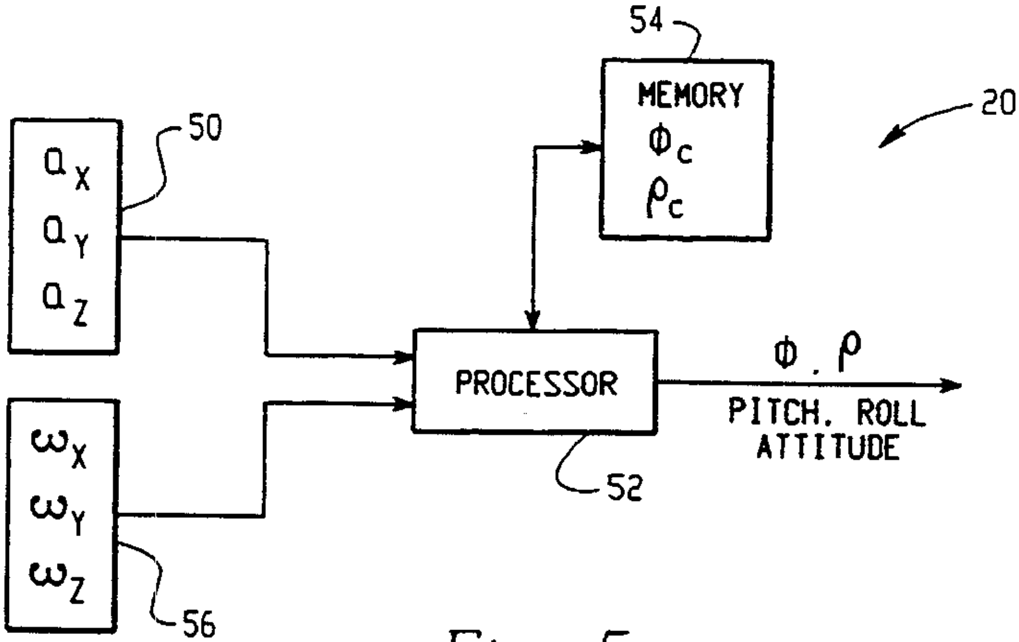

54
MEMORY
Φ_c
ρ_c
20
50
a_X
a_Y
a_Z
PROCESSOR
Φ , ρ
PITCH, ROLL
ATTITUDE
52
ω_X
ω_Y
ω_Z
56

Fig. 5

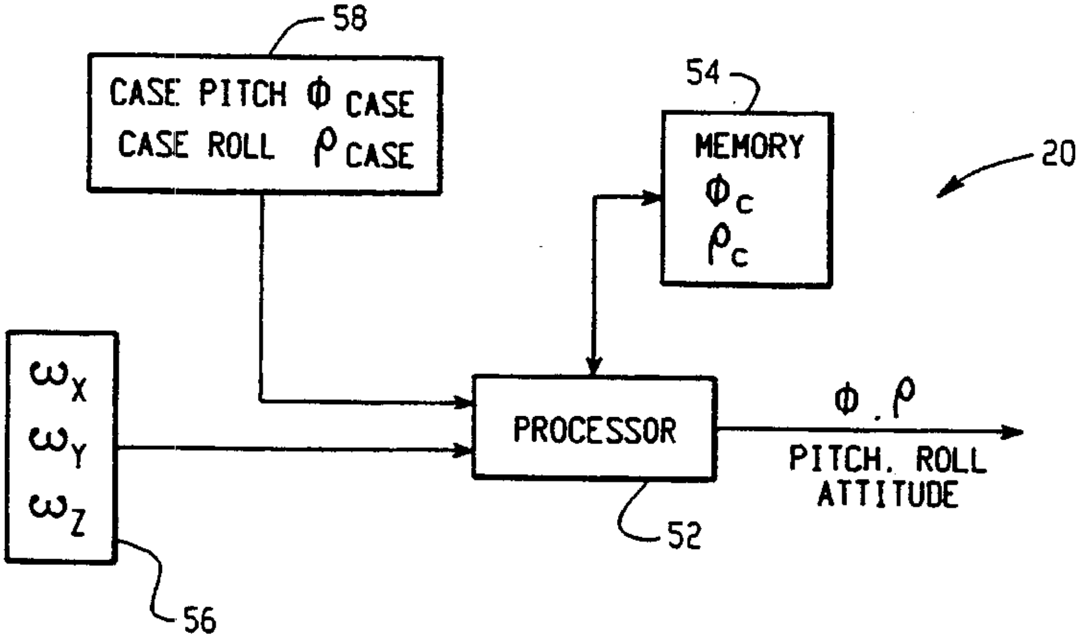

58
CASE PITCH Φ_{CASE}
CASE ROLL ρ_{CASE}
54
MEMORY
Φ_c
ρ_c
20
ω_X
ω_Y
ω_Z
PROCESSOR
Φ , ρ
PITCH, ROLL
ATTITUDE
52
56

Fig. 6

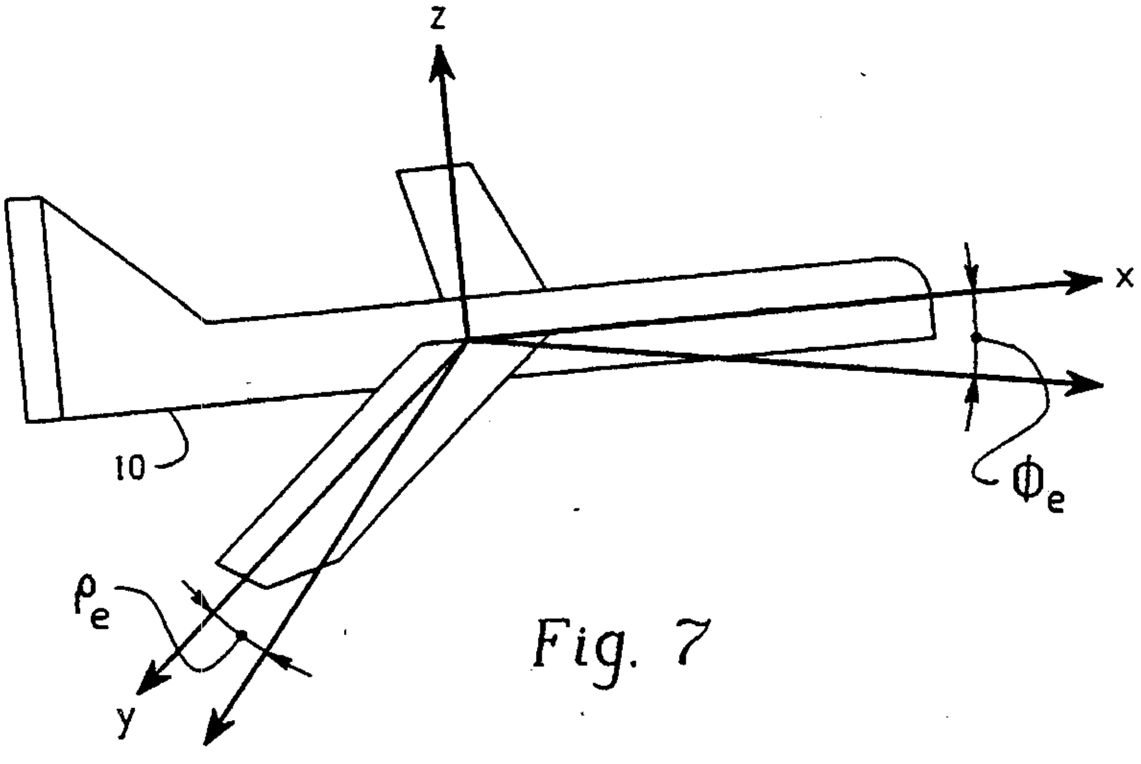


Fig. 7

METHOD OF COMPENSATING FOR INSTALLATION ORIENTATION OF AN ATTITUDE DETERMINING DEVICE ONBOARD A CRAFT

BACKGROUND OF THE INVENTION

The present invention relates to attitude determining devices onboard a mobile craft for determining the attitude of the craft's reference coordinate system with respect to an earth frame of reference, and more specifically, to a method of compensating an attitude measurement of such device for an unknown installation orientation with respect to the reference coordinate system of the craft.

Attitude determining devices for mobile craft, like aircraft, for example, measure the attitude of the moving craft with respect to an outside reference coordinate system, typically known as earth frame. The devices may be installed at a location in the craft in such a manner to be mechanically aligned with the reference coordinate system of the craft. The reference coordinate system of conventional aircraft comprises three orthogonal axes which include a longitudinal or X axis, a lateral or Y axis, and a vertical or Z axis. Motion of the aircraft is generally described as roll which is a rotation about the X axis, pitch which is a rotation about the Y axis and yaw which is a rotation about the Z axis. Pitch, roll and yaw positions are measured as the current angle between the aircraft reference coordinate system and earth frame. Conventionally, aircraft attitude determining devices primarily measure attitude of the aircraft in pitch and roll.

Any inaccuracy in installing an attitude determining device in the craft with respect to the reference coordinate system thereof will result in inaccurate measurement and presentation of the attitude of the craft to either the pilot or other system using the attitude information for display or control purposes. Currently, a method of installing these devices in an aircraft has been to accurately level the aircraft first, and then, install the device using shims or other mechanical apparatus to correctly position the device with respect to the three orthogonal axes forming the coordinate system of the aircraft. This procedure of leveling is adequate for devices mounted in locations of the aircraft remote from the cockpit, but when the device is to be mounted in a cockpit location, such as on an instrument panel, for example, shimming or other mechanical means of adjusting the installation orientation thereof may be precluded due to viewing angle restrictions, aesthetics, . . . etc. Accordingly, some other compensation method will be required.

Currently, units installed on an instrument panel in the cockpit of an aircraft have slots for roll axis alignment and internal mechanical means to accommodate pitch angles other than zero. However, these accommodations for pitch angles make the assumption of zero error in manufacturing tolerances of the aircraft panel angle.

Accordingly, the inventive method described herein below ensures a substantially accurate measurement of aircraft attitude by the attitude determining device with respect to the earth frame of reference. The static installation orientation is automatically determined by the device itself and the attitude measurement is compensated therewith in a processor of the device. Thus, the drawbacks of the current mechanical leveling and alignment procedures are avoided.

SUMMARY OF THE INVENTION

In accordance with the present invention, an attitude determining device which is installed onboard a mobile craft

at an unknown orientation with respect to the reference coordinate system of the craft senses its installation orientation with respect to an earth frame coordinate system when the craft is at rest to obtain a static orientation measurement. An attitude of the mobile craft is measured with the attitude determining device and such measurement is compensated with the static orientation measurement to obtain attitude information of the craft's reference coordinate system with respect to the earth frame coordinate system.

In one embodiment, the acceleration of the attitude determining device is sensed for each of the axes of the reference coordinate system of the mobile craft while at rest and leveled, and a static attitude pitch and static attitude roll of the device are determined from trigonometric functions of ratios of the sensed accelerations. Accordingly, both of the measured attitude pitch and roll of the device are compensated with the static attitude pitch and the static attitude roll, respectively, in the attitude determining device to render attitude information of the craft's reference coordinate system with respect to the earth frame coordinate system.

In another embodiment, a static attitude of the mobile craft in pitch and roll is obtained while the craft is at rest and unleveled. Thereafter, the static attitude craft pitch is used in determining the static attitude pitch of the device and the static attitude craft roll is used in determining the static attitude roll of the device and such static attitude pitch and roll are used respectively to compensate for the measured attitude pitch and roll of the mobile craft in the attitude determining device.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an illustration of an aircraft, with it's reference coordinate system, onboard which an attitude determining device may be installed.

FIG. 2 is an illustration of an attitude determining device including conventional internal acceleration and rate sensors for three orthogonal axes X, Y and Z.

FIG. 3 is a sketch of an attitude determining device mounted on a panel in the cockpit of an aircraft at an unknown orientation to the reference coordinate system of the craft.

FIGS. 4A and 4B are illustrations exemplifying methods of determining the pitch and roll of the attitude determining device onboard a mobile craft using sensed acceleration measurements of the device in accordance with the present invention.

FIG. 5 is a block diagram schematic representing a suitable embodiment of an attitude determining device for performing the method in accordance with the present invention.

FIG. 6 is a block diagram schematic representing an alternate embodiment of an attitude determining device for performing another aspect of the present invention.

FIG. 7 is an illustration of an aircraft having its reference coordinate system unleveled with respect to an earth frame coordinate system allowing for offset angles of pitch and roll respectively from a level attitude.

DESCRIPTION OF THE PREFERRED EMBODIMENT

For the present embodiment, an aircraft will be used, by way of example, as a mobile craft, but it is understood that other similar craft may be used where ever an attitude of the craft is desired and measured with respect to an earth frame of reference coordinate system, hereinafter referred to sim-

ply as earth frame. An aircraft with its reference coordinate system is shown in FIG. 1 including a longitudinal axis depicted as an X axis, a lateral axis depicted as a Y axis, and a vertical axis depicted as a Z axis. Accordingly, roll of the aircraft may be measured as the angular rotation about the X axis, pitch of the aircraft may be measured by the angular rotation about the Y axis and yaw of the aircraft may be measured by the angular rotation about the vertical Z axis. All of these angles are measured with respect to the earth frame. Conventionally, an attitude determining device of an aircraft measures attitude in pitch and roll.

To accurately level the aircraft **10** such that its reference coordinate axes coincides with earth frame, the aircraft is adjusted in attitude such that an acceleration a_z sensed for the Z axis is set substantially equal to a gravity vector g, and the accelerations sensed in the X axis, a_x and in the Y axis, a_y, are set substantially to zero. When these conditions are sensed and stabilized, the aircraft **10** is considered leveled.

FIG. 2 is an illustration of an attitude determining device **20** which may include conventional internal acceleration sensors for the three orthogonal axes X, Y and Z, and may also include conventional rate sensors to measure the rotational motion ω_x, ω_y, and ω_z which are the rotational motions about the respective axes X, Y and Z. An example of such a device is an inertial reference unit manufactured by Honeywell, Inc., model no. HG2001AB02. The internal acceleration sensors (not shown) determine the gravity vector or local vertical g. Thereafter, rotational motion about the respective axes X, Y and Z is sensed by the rate sensors (also not shown), the output of which being integrated over time to maintain a real time craft attitude. Any accumulated integration errors may be removed during static periods by re-aligning the derived output of the device to the local vertical g which procedure is referred to as leveling or erection. These calculations are conventionally performed by a processor internal to the device which samples the sensor outputs and performs the initial and continuous algorithms to produce an attitude solution to be used for display in the aircraft or for a guidance and/or control application for the aircraft.

The attitude determining device **20** may be of a strap down system which is mechanically mounted to the case of the device or a gimballed instrument having elements which are free to rotate in inertial space independent of the case of the unit. In either case, in locating the attitude determining device **20** on board a moving craft, like an aircraft, for example, it may be installed at an unknown orientation with respect to the reference coordinate system of the craft which in the present embodiment are the three orthogonal axes X, Y and Z. It is desired that the device be mounted level with the lateral and longitudinal axes of the craft and aligned with the longitudinal X axis such as shown in FIG. 2, but this may not always be possible due to errors in mechanical leveling or adjusting of the orientation and due to errors in manufacturing tolerances of the device and the aircraft structure where the device is being mounted. This is especially evident when the attitude determining device **20** is mounted on a panel in the cockpit of the aircraft **10** much as illustrated in the sketch of FIG. 3.

Referring to FIG. 3, when the attitude determining device **20** is installed on an aircraft instrument panel **30**, the device may not be aligned with the "waterline" or level line of the aircraft in order to compute accurate attitude information. This is because the panel is often not perpendicular to the waterline and it is not possible in most cases to exactly compensate mechanically for the panel angle offset **40** to the vertical or Z axis. In accordance with the present invention, a method is described below which ensures an accurate calculation of the attitude of a moving craft, like an aircraft, for example, by measuring the installation orientation of the device **20** with respect to the reference coordinate axes of the aircraft and compensating for this orientation mathematically in a processor of the device **20**.

In the present embodiment, upon installation of the device **20** on the instrumentation panel **30** of the craft **10**, whose reference coordinate axes have been leveled to coincide with earth frame, the installation orientation thereof is automatically measured by the installed device **20** and stored in a non-volatile memory thereof. For example, the pitch, ϕ_c and the roll, ρ_c are measured using the acceleration sensors of the device **20** and this measurement is exemplified by the illustrations of FIGS. 4A and 4B. In FIG. 4A, the panel **30** and mounted device **20** is shown in the plane of the axes Z and Y to describe the measurement of the roll angle ρ_c of the installed device **20**. In the plane of the axes Z and Y, the acceleration vectors a_y and a_z are added vectorially to yield the gravity vector g. The installation roll angle ρ_c about the X axis is the angle between the vectors g and a_z and may be determined mathematically in accordance with a trigonometric function of the ratio of a_y to a_z.

Similarly, the perspective of the device **20** installed on the panel **30** in the plane of the axes X and Z is shown in FIG. 4B. Referring to FIG. 4B in this perspective, the acceleration vectors a_z and a_x add up vectorially to yield the gravity vector g and the pitch angle ϕ_c is the angle between the vectors g and a_z which is a rotation about the Y axis. The installation pitch angle ϕ_c may be determined mathematically in accordance with a trigonometric function of the ratio of a_x to a_z. In the present embodiment, the trigonometric function used for determining the installed roll and pitch angles for static orientation of the device **20** is the arcsine.

A block diagram schematic representing a suitable embodiment of the attitude determining device is shown in FIG. 5. Referring to FIG. 5, after the device is installed on the instrument panel of a leveled craft **10**, for example, and power is subsequently activated to the device **20**, an internal processor **52** of the device **20** samples the outputs of the acceleration senors depicted in the block **50** in all three axes a_x, a_y, a_z. The static angles of the device **20** with respect to earth frame are determined by the processor **52** from the static acceleration measurements based on the trigonometric function described above. The installation angles ϕ_c and ρ_c are read from non-volatile memory **54** of the device **20** and the attitude of the craft **10** with respect to earth frame is determined by the processor **52** by subtracting these installation angles ϕ_c and ρ_c from the static angles of the device **20** with respect to earth frame. Thereafter, the pitch and roll attitude angles of the moving craft **10** are computed conventionally by the processor **52** via the rate sensors ω_x, ω_y, ω_z which are shown at block **56** of the device **20** and received by the processor **52**. In a gimballed attitude determining device the angles of the spin axis, measured using synchros or other such devices, with respect to the case are corrected by subtracting the installation angles ϕ_c and ρ_c to yield actual aircraft pitch and roll attitude angles.

In summary, for the case in which the craft is leveled according to the description supplied above prior to sensing the installation orientation of device **20**, the processor **52** samples the outputs a_x, a_y and a_z of the acceleration sensors **50**. The static installation angles ϕ_c and ρ_c are determined by the processor **52** from the static acceleration measurements based on the trigonometric function described above and are stored in a non-volatile memory **54** for use in compensating the attitude measurements with respect to earth frame.

Power to device **20** may then be removed. Subsequent power application to device **20** would allow a measurement of the attitude of the aircraft, i.e. orientation of the aircraft's reference coordinate axes with respect to earth frame, to be correctly determined by processor **52** using ϕ_c and ρ_c from the memory **54**.

In some applications, the attitude determining device **20** may not include acceleration sensors **50** but rather include level sensors for sensing directly the pitch ϕ_{case} and roll ρ_{case} of the installed case with respect to the earth frame. A block diagram schematic suitable for exemplifying an alternate embodiment of the device **20** including level sensors is shown in FIG. **6** with the level sensing depicted at **58**. Like reference numerals are given to the other elements of the device **20** to match those described in connection with the embodiment of FIG. **5**. In operation, the processor receives the installation orientation angles ϕ_{case} and ρ_{case} measured by the level sensors at **58** and stores them in the non-volatile memory **54** as ϕ_c and ρ_c to be accessed subsequently in compensating for the attitude angle measurements as described in connection with the embodiment of FIG. **5**.

The foregoing method provides for compensating for the installation orientation of the device **20** for a leveled craft. If the craft **10** is not in a level attitude as shown in the exemplified illustration of FIG. **7**, the actual unlevel aircraft attitude may be measured i.e. reference coordinate axes of the aircraft with respect to earth frame, allowing the processor **52** to determine the offset angles of pitch and roll, ϕ_a and ρ_a, respectively, from a level attitude. These pitch and roll angle offsets from a level condition of the aircraft may be input either manually or electrically to the processor **52** of the device **20** as shown in FIGS. **5** and **6**. In addition, the static installation angles are measured by device **20** with respect to the unleveled aircraft coordinate axes. In order for the processor **52** of device **20** to calculate the effective static installation pitch and roll angles, ϕ_a and ρ_a of the case with respect to a level reference coordinate system of the craft **10**, it may subtract the measured offset angles from their respective measured installation angles. The effective static orientation measurements of the case with respect to the craft's reference coordinate system may then be stored in the memory **54** as shown in FIGS. **5** and **6** in order to compensate for the installation orientation of the device in the craft **10** as described supra.

In attitude determining devices in which there is no non-volatile memory, the step of sensing the installation orientation of the device to obtain a static orientation measurement with respect to the reference coordinate system of the craft may be performed each time the power is turned on and the aircraft is in a static condition. The resulting static orientation measurement may be stored in the memory of the device for use in compensating for attitude measurements for the moving craft.

While the invention has been described herein in connection with a preferred embodiment, it should not be so limited, but rather construed in accordance with the breath and broad scope of the claim set appended hereto.

We claim:

1. A method of compensating for installation orientation of an attitude determining device on-board a mobile craft with respect to a reference coordinate system of said craft to obtain attitude information of said craft from said device based on an earth frame coordinate system, said method comprising the steps of:

installing said attitude determining device on-board said mobile craft at an unknown orientation with respect to said reference coordinate system of said craft;

sensing the installation orientation of said attitude determining device with respect to said earth frame coordinate system when said craft is at rest to obtain a static orientation measurement of said device;

measuring an attitude of said mobile craft with said attitude determining device; and

compensating said craft attitude measurement of said device with said static orientation measurement to obtain attitude information of said craft's reference coordinate system with respect to said earth frame coordinate system.

2. The method in accordance with claim **1** wherein the reference coordinate system of said craft includes three orthogonal axes—a vertical or z axis, a longitudinal or x axis and a lateral or y axis.

3. The method in accordance with claim **2** wherein the step of sensing includes:

leveling the craft while at rest such that the z axis is aligned with a gravity vector and no substantial at rest acceleration exists at the x and y axes;

sensing the acceleration at the device for each of said three axes—a(x), a(y) and a(z) while the craft is at rest and leveled; and

determining the static orientation measurement of said device based on a function of said three sensed axis accelerations—a(x), a(y) and a(z).

4. The method in accordance with claim **3** wherein the step of determining includes:

determining a static attitude pitch of the device as a trigonometric function of a ratio of the sensed accelerations a(x) and a(z); and

determining a static attitude roll of the device as a trigonometric function of a ratio of the sensed accelerations a(y) and a(z); and

wherein the static orientation measurement of the device comprises the determined static attitude pitch and static attitude roll.

5. The method in accordance with claim **4** wherein the step of measuring includes measuring an attitude pitch and an attitude roll of the mobile craft with said device; and the step of compensating includes compensating the measured attitude pitch with the static attitude pitch and compensating the measured attitude roll with the static attitude roll.

6. The method in accordance with claim **2** wherein the step of sensing includes:

sensing the acceleration at the device for each of said three axes—a(x), a(y) and a(z) while the craft is at rest and unleveled;

obtaining a static attitude of the craft while at rest and unleveled;

determining the static orientation measurement of said device based on said static craft attitude and a function of said three sensed axis accelerations—a(x), a(y) and a(z).

7. The method in accordance with claim **6** wherein the step of obtaining includes:

obtaining a static craft pitch and a static craft roll; and

the step of determining includes:

determining a static attitude pitch of the device as a trigonometric function of a ratio of the sensed accelerations a(x) and a(z) and said static craft pitch; and

determining a static attitude roll of the device as a trigonometric function of a ratio of the sensed accelerations a(y) and a(z) and said static craft roll; and

wherein the static orientation measurement of the device comprises the determined static attitude pitch and static attitude roll.

8. The method in accordance with claim 7 wherein the step of measuring includes measuring an attitude pitch and an attitude roll of the mobile craft with said device; and the step of compensating includes compensating the measured attitude pitch with the static attitude pitch and compensating the measured attitude roll with the static attitude roll.

9. The method in accordance with claim 1 wherein the step of sensing includes:

leveling the craft while at rest;

sensing an installation pitch and an installation roll of the device while the craft is at rest and leveled; and

wherein the static orientation measurement of the device comprises the sensed installation pitch and roll of the device.

10. The method in accordance with claim 9 wherein the step of measuring includes measuring an attitude pitch and an attitude roll of the mobile craft with said device; and the step of compensating includes compensating the measured attitude pitch with the sensed installation pitch and compensating the measured attitude roll with the sensed installation roll.

11. The method in accordance with claim 1 wherein the step of sensing includes:

sensing an installation pitch and an installation roll of the device while the craft is at rest and unleveled;

obtaining a static attitude pitch and a static attitude roll of the craft while at rest and unleveled;

determining a static attitude pitch of said device based on a combination of said static craft attitude pitch and said installation pitch and a static attitude roll of the device based on a combination of said static craft attitude roll and said installation roll;

wherein the static orientation measurement of the device comprises the determined static device attitude pitch and static device attitude roll.

12. The method in accordance with claim 11 wherein the step of measuring includes measuring an attitude pitch and an attitude roll of the mobile craft with said device; and the step of compensating includes compensating the measured attitude pitch with the static device attitude pitch and compensating the measured attitude roll with the static device attitude roll.

13. The method in accordance with claim 1 wherein the mobile craft is an aircraft, and the attitude device is installed on an instrumentation panel of said aircraft.

14. The method in accordance with claim 1 wherein the attitude determining device comprises a strapdown attitude instrument.

15. The method in accordance with claim 1 wherein the attitude determining device comprises a gimballed attitude instrument.

16. A method of compensating for installation orientation of an attitude determining device on-board a mobile craft with respect to a reference coordinate system of said craft to obtain attitude information of said craft from said device based on an earth frame coordinate system, said method comprising the steps of:

installing said attitude determining device on-board said mobile craft at an unknown orientation with respect to said reference coordinate system of said craft;

sensing the installation orientation of said attitude determining device with respect to said earth frame coordinate system when said craft is at rest to obtain a static orientation measurement of said device;

storing said static orientation measurement in a memory;

measuring an attitude of said mobile craft with said attitude determining device;

retrieving said static orientation measurement from said memory to a processor of said device; and

compensating said craft attitude measurement with said retrieved static orientation measurement in said processor to obtain attitude information of said craft's reference coordinate system with respect to said earth frame coordinate system.

17. The method in accordance with claim 16 wherein the step of sensing includes:

sensing the installation orientation of the device with sensors disposed at the device;

receiving in the processor sensed orientation data of said sensors; and

processing the received data in the processor to obtain the static orientation measurement of the device.

18. The method in accordance with claim 17 wherein the step of sensing includes sensing the installation orientation of the device with acceleration sensors.

19. The method in accordance with claim 17 wherein the step of sensing includes sensing the installation orientation of the device with level sensors.

20. The method in accordance with claim 16 wherein the step of compensating includes:

obtaining a static attitude of the craft while at rest and unleveled;

providing said static craft attitude to the processor of said device; and

compensating said craft attitude measurement with said retrieved static orientation measurement and static craft attitude in said processor to obtain attitude information of the craft's reference coordinate system with respect to the earth frame coordinate system.

* * * * *

JS 44 (Rev. 3/99)

CIVIL COVER SHEET

The JS-44 civil cover sheet and the information contained herein neither replace nor supplement the filing and service of pleadings or other papers as required by law, except as provided by local rules of court. This form, approved by the Judicial Conference of the United States in September 1974, is required for the use of the Clerk of Court for the purpose of initiating the civil docket sheet. (SEE INSTRUCTIONS ON THE REVERSE OF THE FORM.)

I. (a) PLAINTIFFS

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f/k/a B.F. Goodrich Avionics Systems, Inc.

County of Residence of First Listed
(IN U.S. PLAINTIFF CASES ONLY)

NOTE: IN LAND CONDEMNATION CASES, USE THE LOCATION OF THE LAND INVOLVED.

Attorneys (If Known)

04-12672 NG

II. BASIS OF JURISDICTION (Place an "X" in One Box Only)

☐ 1 U.S. Government Plaintiff
☒ 3 Federal Question (U.S. Government Not a Party)
☐ 2 U.S. Government Defendant
☐ 4 Diversity (Indicate Citizenship of Parties in Item III)

III. CITIZENSHIP OF PRINCIPAL PARTIES (Place an "X" in One Box for Plaintiff and One Box for Defendant)
(For Diversity Cases Only)

	PTF	DEF		PTF	DEF
Citizen of This State	☐ 1	☐ 1	Incorporated *or* Principal Place of Business In This State	☐ 4	☐ 4
Citizen of Another State	☐ 2	☐ 2	Incorporated *and* Principal Place of Business In Another State	☐ 5	☐ 5
Citizen or Subject of a Foreign Country	☐ 3	☐ 3	Foreign Nation	☐ 6	☐ 6

IV. NATURE OF SUIT (Place an "X" in One Box Only)

CONTRACT
☐ 110 Insurance
☐ 120 Marine
☐ 130 Miller Act
☐ 140 Negotiable Instrument
☐ 150 Recovery of Overpayment & Enforcement of Judgment
☐ 151 Medicare Act
☐ 152 Recovery of Defaulted Student Loans (Excl. Veterans)
☐ 153 Recovery of Overpayment of Veteran's Benefits
☐ 160 Stockholders' Suits
☐ 190 Other Contract
☐ 195 Contract Product Liability

REAL PROPERTY
☐ 210 Land Condemnation
☐ 220 Foreclosure
☐ 230 Rent Lease & Ejectment
☐ 240 Torts to Land
☐ 245 Tort Product Liability
☐ 290 All Other Real Property

TORTS

PERSONAL INJURY
☐ 310 Airplane
☐ 315 Airplane Product Liability
☐ 320 Assault, Libel & Slander
☐ 330 Federal Employers' Liability
☐ 340 Marine
☐ 345 Marine Product Liability
☐ 350 Motor Vehicle
☐ 355 Motor Vehicle Product Liability
☐ 360 Other Personal Injury

PERSONAL INJURY
☐ 362 Personal Injury—Med. Malpractice
☐ 365 Personal Injury — Product Liability
☐ 368 Asbestos Personal Injury Product Liability

PERSONAL PROPERTY
☐ 370 Other Fraud
☐ 371 Truth in Lending
☐ 380 Other Personal Property Damage
☐ 385 Property Damage Product Liability

CIVIL RIGHTS
☐ 441 Voting
☐ 442 Employment
☐ 443 Housing/ Accommodations
☐ 444 Welfare
☐ 440 Other Civil Rights

PRISONER PETITIONS
☐ 510 Motions to Vacate Sentence
Habeas Corpus:
☐ 530 General
☐ 535 Death Penalty
☐ 540 Mandamus & Other
☐ 550 Civil Rights
☐ 555 Prison Condition

FORFEITURE/PENALTY
☐ 610 Agriculture
☐ 620 Other Food & Drug
☐ 625 Drug Related Seizure of Property 21 USC
☐ 630 Liquor Laws
☐ 640 R.R. & Truck
☐ 650 Airline Regs.
☐ 660 Occupational Safety/Health
☐ 690 Other

LABOR
☐ 710 Fair Labor Standards Act
☐ 720 Labor/Mgmt. Relations
☐ 730 Labor/Mgmt.Reporting & Disclosure Act
☐ 740 Railway Labor Act
☐ 790 Other Labor Litigation
☐ 791 Empl. Ret. Inc. Security Act

BANKRUPTCY
☐ 422 Appeal 28 USC 158
☐ 423 Withdrawal 28 USC 157

PROPERTY RIGHTS
☐ 820 Copyrights
☒ 830 Patent
☐ 840 Trademark

SOCIAL SECURITY
☐ 861 HIA (1395ff)
☐ 862 Black Lung (923)
☐ 863 DIWC/DIWW (405(g))
☐ 864 SSID Title XVI
☐ 865 RSI (405(g))

FEDERAL TAX SUITS
☐ 870 Taxes (U.S. Plaintiff or Defendant)
☐ 871 IRS—Third Party 26 USC 7609

OTHER STATUTES
☐ 400 State Reapportionment
☐ 410 Antitrust
☐ 430 Banks and Banking
☐ 450 Commerce/ICC Rates/etc.
☐ 460 Deportation
☐ 470 Racketeer Influenced and Corrupt Organizations
☐ 810 Selective Service
☐ 850 Securities/Commodities/ Exchange
☐ 875 Customer Challenge 12 USC 3410
☐ 891 Agricultural Acts
☐ 892 Economic Stabilization Act
☐ 893 Environmental Matters
☐ 894 Energy Allocation Act
☐ 895 Freedom of Information Act
☐ 900 Appeal of Fee Determination Under Equal Access to Justice
☐ 950 Constitutionality of State Statutes
☐ 890 Other Statutory Actions

V. ORIGIN (PLACE AN "X" IN ONE BOX ONLY)

XX 1 Original Proceeding
☐ 2 Removed from State Court
☐ 3 Remanded from Appellate Court
☐ 4 Reinstated or Reopened
☐ 5 Transferred from another district (specify)
☐ 6 Multidistrict Litigation
☐ 7 Appeal to District Judge from Magistrate Judgment

VI. CAUSE OF ACTION (Cite the U.S. Civil Statute under which you are filing and write brief statement of cause. Do not cite jurisdictional statutes unless diversity.)

A Declaratory Judgment Complaint seeking declaration of non-infringement and invalidity of U.S. Patent No. 5, 841, 018.

VII. REQUESTED IN COMPLAINT: ☐ CHECK IF THIS IS A CLASS ACTION UNDER F.R.C.P. 23 **DEMAND $**

CHECK YES only if demanded in complaint: **JURY DEMAND:** ☐ Yes ☐ No

VIII. RELATED CASE(S) IF ANY (See instructions): JUDGE DOCKET NUMBER

DATE 12/21/04 SIGNATURE OF ATTORNEY OF RECORD Jason C Kravitz

FOR OFFICE USE ONLY

RECEIPT # AMOUNT APPLYING IFP JUDGE MAG. JUDGE

UNITED STATES DISTRICT COURT
DISTRICT OF MASSACHUSETTS

1. Title of case (name of first party on each side only) Avidyne Corporation v. L-3 Communications Avionics Systems, Inc. f/k/a B.F. Goodrich Avionics Systems, Inc.

2. Category in which the case belongs based upon the numbered nature of suit code listed on the civil cover sheet. (See local rule 40.1(a)(1)).

☐ I. 160, 410, 470, R.23, REGARDLESS OF NATURE OF SUIT.

☒ II. 195, 368, 400, 440, 441-444, 540, 550, 555, 625, 710, 720, 730, 740, 790, 791, 820*, 830*, 840*, 850, 890, 892-894, 895, 950. *Also complete AO 120 or AO 121 for patent, trademark or copyright cases

☐ III. 110, 120, 130, 140, 151, 190, 210, 230, 240, 245, 290, 310, 315, 320, 330, 340, 345, 350, 355, 360, 362, 365, 370, 371, 380, 385, 450, 891.

☐ IV. 220, 422, 423, 430, 460, 510, 530, 610, 620, 630, 640, 650, 660, 690, 810, 861-865, 870, 871, 875, 900.

04 - 12672 NG

☐ V. 150, 152, 153.

3. Title and number, if any, of related cases. (See local rule 40.1(g)). If more than one prior related case has been filed in this district please indicate the title and number of the first filed case in this court.

N/A

4. Has a prior action between the same parties and based on the same claim ever been filed in this court?

YES ☐ NO ☒

5. Does the complaint in this case question the constitutionality of an act of congress affecting the public interest? (See 28 USC §2403)

YES ☐ NO ☒

If so, is the U.S.A. or an officer, agent or employee of the U.S. a party?

YES ☐ NO ☐

6. Is this case required to be heard and determined by a district court of three judges pursuant to title 28 USC §2284?

YES ☐ NO ☒

7. Do all of the parties in this action, excluding governmental agencies of the united states and the Commonwealth of Massachusetts ("governmental agencies"), residing in Massachusetts reside in the same division? - (See Local Rule 40.1(d)).

YES ☐ NO ☒

A. If yes, in which division do all of the non-governmental parties reside?

Eastern Division ☐ Central Division ☐ Western Division ☐

B. If no, in which division do the majority of the plaintiffs or the only parties, excluding governmental agencies, residing in Massachusetts reside?

Eastern Division ☐ Central Division ☐ Western Division ☐

8. If filing a Notice of Removal - are there any motions pending in the state court requiring the attention of this Court? (If yes, submit a separate sheet identifying the motions)

YES ☐ NO ☐

(PLEASE TYPE OR PRINT)

ATTORNEY'S NAME Jason C. Kravitz, Esq.

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